

# Product Drying and Moisture Control

*Improve Quality and Minimize Energy Usage*

Industry: Paper, Chemicals, Lumber, Food,  
Textiles, and Pharmaceuticals

## Background

**Overview.** Controlling the removal of moisture from various materials is still a trial-and-error operation in many plants—in spite of the existence of modern measurement and control technologies that could automate this important function. Achieving specified moisture content in many types of products is vital for meeting competitive product quality standards.

The typical approach to drying often results in either under-drying or over-drying the product since it is difficult to control continuously the point at which drying is complete.

**Energy Consumption.** Drying processes are among the largest consumers of energy to be found in industry. If the product is over-dried, energy (in the form of heat) is wasted, and potential quality issues can arise. If the product is under-dried in order to save money on energy, quality issues could require the product to be re-dried or even thrown out. Any method that can maximize product quality while minimizing energy usage is extremely valuable.

**Applications.** Some of the industrial applications that incorporate drying/moisture control are:

- *Paper:* Drying hoods of paper machines
- *Chemicals:* Drying of plastics, pigments, and powdered chemicals
- *Lumber:* Drying kiln control for all kinds of wood products
- *Food:* Drying of grains, cereals, fruits, snacks, cheese, and pasta
- *Textiles:* On-line drying of fabric rolls and carpeting
- *Pharmaceuticals:* Moisture control in a wide range of powdered products and pill manufacturing.

## Solution

**Overview.** Drying processes are necessary in the production of a wide variety of products involving materials in solid, granular, fibrous, and powder form. Major industries involved are food, chemicals, building materials, textiles, plastic, semiconductors, paper, tobacco, wood and pharmaceuticals.

**Equipment Available.** Equipment for drying/moisture control is available in a broad variety of designs, including ovens, kilns, dryer hoods, and numerous types of industrial dryers.

A single dryer may remove moisture at rates varying from as little as ounces per hour to as much as tons per hour.

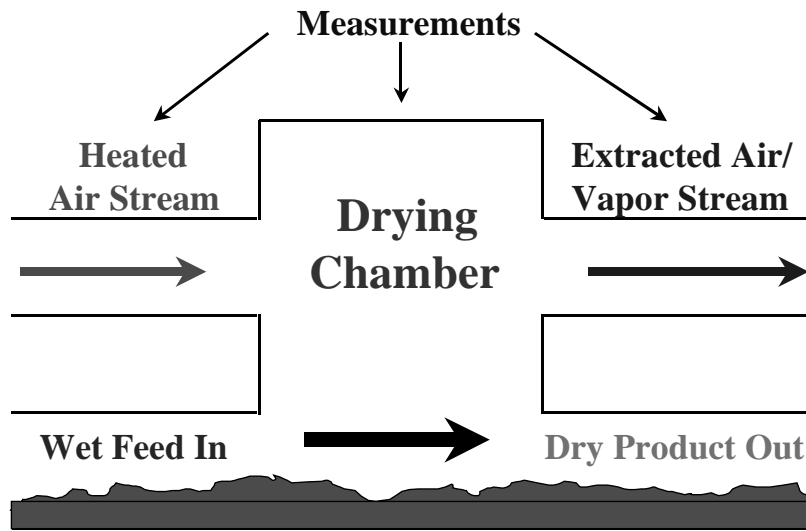
Drying temperatures can reach as high as 1400 °F (760 °C) or as low as -40 °F (-40 °C).

Despite such diversity of equipment and operating conditions, control analysis logic is applicable to most of them.

**The Drying Process Model.** It is helpful to first reduce all these systems to a basic model that highlights the most important points to consider for improving performance.

A generalized schematic of a drying system is presented in Figure 1. It shows the elements that are common to virtually every drying operation:

- Wet material is fed into a drying space.
- The input heat source is provided as an air stream, conductive surface, radiation, etc.
- The final product is dried to meet specifications.
- A vapor-laden exit flow stream contains the extracted moisture.



**Figure 1 – The Drying Process Model**

**Moisture Sensing On-line.** Proper control begins with measurement of moisture and other variables at a variety of points. During the actual drying operation, it is usually impractical to directly measure the embedded moisture in the product. This means that the level of product dryness must be inferred from the measurement of other related parameters—such as temperatures and moisture content of drying agents like air and gas streams.

Accurate and continuous sensing of dew point and dry bulb temperatures in the dryer space and in the flow streams of heating gases and extracted vapors becomes the key to an effective automation scheme. With these measurements and some knowledge of the drying process dynamics, the material and heat balance conditions that achieve effective drying can be derived.

However, effective drying alone is not sufficient to improve product quality/throughput and minimize energy usage. The next step is to add advanced control for guaranteed product quality and repeatability at a reduced manufacturing cost.

**Advanced Control Strategies.** Figure 1 shows the typical drying application model. This model is sufficient for small dryers that neither measure nor control moisture because the ROI is minimal in comparison to the cost of the installed equipment for the job.

In larger dryers, however, the method of passing heated air over the wet product can waste a large amount of energy. This is because the air will typically be able to hold more moisture than it picks up on the first pass, as evidenced by the dew point of the outlet air.

There is a dew point temperature at which the heated air can hold little or no more moisture. Heated air that is below that point can be moved more slowly past the product, or it can be re-circulated until it no longer is feasible to continue using the same air and drier air must be brought in.

Dew point and dry bulb temperature measurements are taken from the exiting vapor stream and brought into a single unit controller. The controller continuously monitors these inputs and based on the control strategy makes adjustments to the temperature and flow rate of the input air stream.

This approach minimizes energy usage requirements for the dryer while ensuring that the product achieves the desired moisture level.

An advanced control scheme for varying the flow rate and temperature of the air is shown in Figure 2.

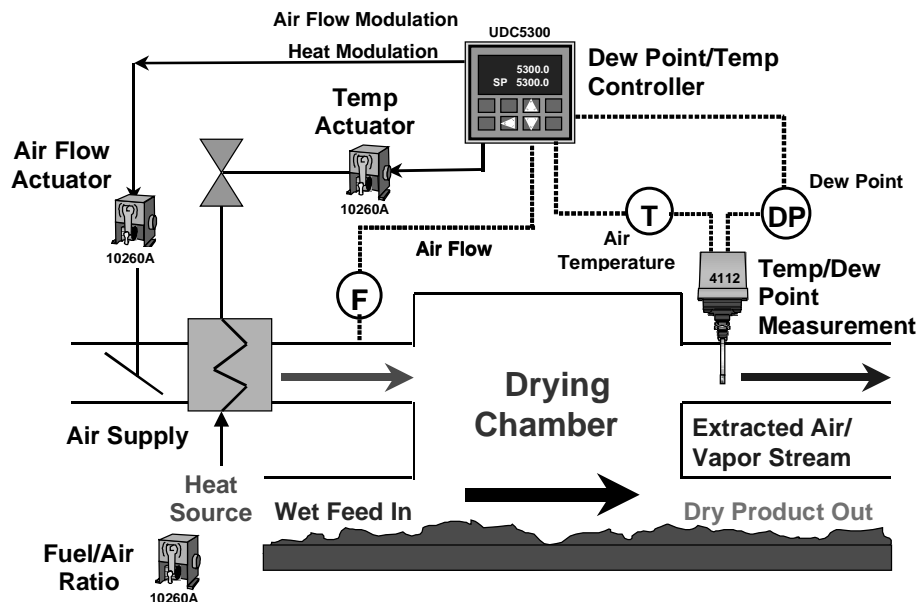


Figure 2 – Control Diagram 1 for Improved Drying and Moisture Control

The controller output connected to damper actuators continuously adjusts the temperature or airflow to arrive at an optimum environment for drying. Any number of combinations of air flow and heat input can deliver the desired product quality. Each combination results in different costs of operation. In practice, these combinations are usually uncovered by trial and error.

When a process controller is used to determine the “right combination”, the operator now has a working recipe of the optimized process and cost of operation for guaranteed repeatability.

Some of the bigger dryers can require large amounts of heated air, yet require a constant flow of that air in order to provide fast drying. For these dryers, the control scheme shown in Figure 3 is more feasible.

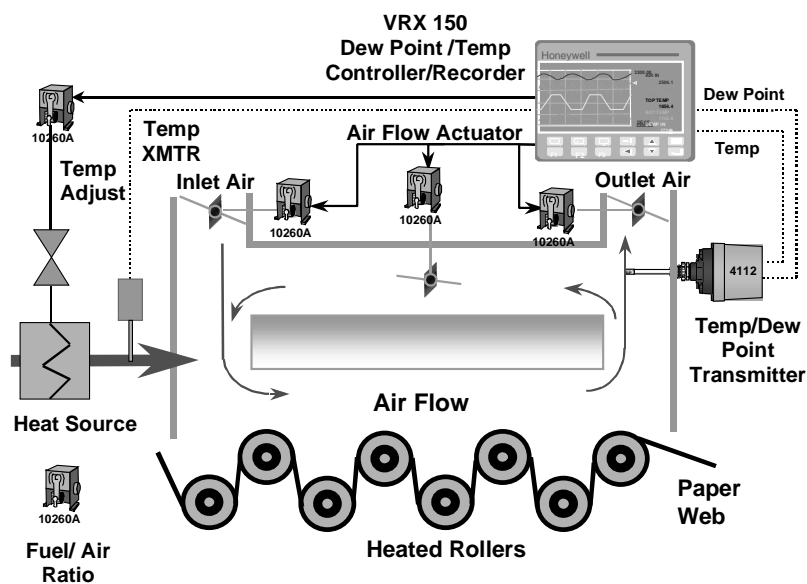


Figure 3 – Control Diagram 2 for Improved Drying and Moisture Control

**Example.** A paper dryer hood is one such example. In this case, the dry, heated air can be brought into the dryer hood and re-circulated through the use of dampers until the maximum dew point is reached. At that point, the inlet/outlet dampers are opened again and new air is brought through. This approach ensures that the flow rate is maintained without wasting heated air.

**Conclusion.** As presented in the prior paragraphs, process drying and moisture control can be achieved easily through a combination of the correct moisture measurement sensor and advanced process control strategy based on your particular needs.

The primary benefit to the plant is consistently improved product quality and increased throughput with little or no product waste.

A secondary benefit is reduced energy usage through improved drying control. Together these benefits increase product margins and lower plant costs respectively.

Honeywell's advanced drying and moisture control strategy solution has all the tools you will need to begin realizing the benefits of increased product margins and lower plant costs from your drying applications.

## Benefits Summary

In drying operations, the challenge is to track and control product moisture while the drying operation is in progress rather than waiting to sample the finished product after it leaves the dryer.

This involves three major considerations:

- A sensor that can measure moisture concentration and temperature directly in the process environment
- An understanding of the material and energy balances involved in the drying process
- An automatic control strategy to optimize operations, considering product quality, energy costs, production rates, process downtime, and maintenance.

## Implementation

### Honeywell's Advanced Control Strategy Solution – *The Dew Point Measurement.*

A stable and durable moisture sensor for drying applications is a must. Honeywell's 4112/4114 Dew Point and Temperature transmitter/sensor design overcomes many of the shortcomings associated with other sensor designs, including poor resistance to solid and liquid contamination as well as frequent calibrations.

The 4112 and 4114 sensors have a special patented design that accurately and reliably measures moisture while located in the process, without the need for frequent cleaning, calibration, or sensor replacement.

Honeywell's moisture sensor is constructed of a very inert thermoset polymer that is virtually immune to any solvent. There is nothing inherent in the sensor material or construction that dictates re-calibration after a specific interval of time.

Process contaminants, such as oils, dirt, or dust pose no problem for the sensor, which will provide accurate and simple moisture measurements even when partially fouled. If the sensor does get coated with contaminants, it can be wiped off with no need for re-calibration. Should condensation ever occur, the sensor can be removed from the process, allowed to dry, and then placed back into service, eliminating probe replacement costs.

Advanced sensor technology is at the heart of this patented guarded-polymer-layer capacitance sensor. The high-performance sensing element, in combination with platinum RTD sensor and an advanced probe design, allows the sensor to operate under the unique conditions presented by the instrument air application.

Honeywell offers two solutions: either the 4112 with display or the 4114 transmitter without a display. Each is suitable for all your dryer application needs.

## The 4112 Dew Point and Temperature Transmitter



### Features

- Easy-to-read dual-LCD display for local readout of both dew point and dry bulb temperatures
- *In-situ* use
- Patented chemical- and contaminant-resistant sensor
- High-performance probe design
- Measurement of temperatures up to 365 °F (1000 °F with cooler option)
- Explosion-proof housing
- Suitable for use in hazardous areas as defined by CSA and FM standards
- NEMA 4X compliance
- Two 4-20 mA outputs for dew point and dry bulb temperature signals from one instrument

### Benefits

- Extended life of equipment with sensor recovery from saturation
- Reduced product costs since dew point and temperature-sensing elements are in one instrument
- Reduced product costs since sampling system not required
- Lower energy costs
- Reduced calibration maintenance
- Lower maintenance costs (sensor can be wiped clean if fouled, then returned to the process)

## The 4114 Dew Point and Temperature Transmitter



### Features

- *In-situ* use
- Unequaled contaminant-resistant sensor
- High-performance probe design
- Rugged, low-maintenance sensor
- NEMA 4X compliance

### Benefits

- Extended life of instrumentation with sensor recovery from saturation
- Lower energy costs
- Reduced calibration maintenance
- Lower product costs with no need for sampling systems
- Two 4-20 mA outputs for dew point and dry bulb temperature signals from one instrument
- No need for extra temperature-sensing element

### Calibration Kit

Honeywell also offers a convenient calibration kit that allows the user to perform calibration checks in the field. Honeywell's sensor does not require frequent calibrations; however, the user's own quality system requirements or regulatory requirements may demand them.

In these cases, Honeywell suggests calibration checks, not necessarily full re-calibration, at 12-month intervals. This eliminates the expense (time and money) associated with sending the transmitter back to the factory for re-calibration.

## The Advanced Control Strategy I

Advanced controls provide the intelligence to compensate for normal and abnormal variations in the materials and the ambient conditions in a dryer. A quality digital control system responds to changes in the measured parameters by adjusting airflow and temperature with the appropriate action. Digital electronics offer precision, reliability, and flexibility to the process operation and reduce energy consumption.

Honeywell's UDC5300 provides the flexibility to accommodate the special requirements of a state-of-the-art drying process. Most process controllers cannot perform both the math and logic needed to compensate for the wide range of conditions that occur inside the dryer. Variations in the supply air temperature and humidity challenge this type of control system. The UDC5300 with function block configuration software can be configured to respond to these extremes. When process excursions do occur, alarms inform the operator and corrective action can take place at the moment of need.

The UDC5300 also provides process security with the use of PCMCIA memory cards. These cards operate like floppy disks. The PC Cards can save successful configurations and process settings. In the event of a failure the configuration can be quickly loaded into a spare unit to resume operation. These same PC Memory cards can be used to capture process history that can then be transferred to a Personal Computer for analysis.

Honeywell's Statistical Data Analysis (SDA) Software converts any PC into a powerful analytical tool. The data storage function of the UDC5300 is unique among dual loop controllers. With the 5300 controller, energy consumption costs are reduced and product quality is improved.



## The UDC 5300 Dual Loop Logic Controller

### Features

- Single Controller maintains Dew Point, Air Flow and Temperature of Air
- Industrial NEMA 12 enclosure for factory operation.
- Math and logic functions with function blocks enable customized control strategies
- Performs PLC like functions in a 1/4 DIN controller
- Stores valuable recipe and process history information in on-board PCMCIA memory card
- Optional Data Storage for Process Data Archiving
- Enables data analysis on PC with SDA software application
- Optional Data Communications

### Benefits

- Reduction of energy consumption by eliminating over-drying
- Fewer Process deviations: Alarm limits alert Operator of any excursions
- Consistent Product Quality: Automatic feedback control provides continuous proportional adjustment
- Lower operation costs: intervention is not required as raw materials and external conditions change
- Low Maintenance costs

## Advanced Control Strategy II

When more process connections are required or process data recording is desired a Video recorder is the more logical choice. Controllers provide the needed control strategy to optimize your process. However, for longer-term process improvements, recorded data provides the objective information to detect trends and sources of quality deviations.

Most paper and video recorders do not perform the math and logic needed to control processes. Therefore PLCs or ancillary controllers must be added to do the control functions. Multiple pieces of hardware introduce technical complication and expense.

The VRX150 is unique among video recorders in that it combines the visibility of color graphics, digital history, and control functions into one integrated package.

The 10.4-inch graphic display of a VRX150 helps operators to understand the performance of the drying equipment. Trend displays give a historic perspective as well as an instantaneous view of the process status.

The VRX150's digital recording functions permits quality control and management to review valuable data from a secure floppy. Data is encrypted to prevent unauthorized tampering. This is a definite benefit in food and pharmaceutical drying applications. Data can be replayed on the VRX150 without interrupting the drying process. It can also be viewed from a Personal Computer using Honeywell's SDA software package. Once in the PC, the data can be transferred to other software applications such as Microsoft's Excel. With the advent of Super Disk technology, it is possible to retain a year's worth of data on one floppy.

As with the 5300 controller, Honeywell's VRX150 provides the flexibility to accommodate the special requirements of a state-of-the-art drying process. The combination of simplicity and sophistication ensure the optimal performance of the drying equipment. The payback is savings by improved energy efficiency, more consistent drying quality, and less waste.



**The VRX 150 Video Controller**

### Features

- 10.4 inch high-resolution graphics are unique to a unit that does both electronic recording and control.
- Function Blocks to perform complex math and logic algorithms
- Floppy Disks to save and load control configurations and archive valuable process history
- Historic Data can be analyzed on a Personal Computer with SDA software
- Control Configurations can be developed on a Personal Computer and loaded to Controller using SCF software.

### Benefits

- Reduced energy costs from over-drying
- Lower maintenance costs with paperless recording for process reporting
- Improved product quality due to fewer process deviations: Alarm limits alert Operator of any excursions
- Consistent product quality with automatic feedback control providing continuous proportional adjustment
- Lower operation costs since intervention is not required as raw materials and external conditions change

## Equipment for Improved Performance

Accurate, repeatable and low maintenance actuators are a must to ensure maximum dryer efficiency and continual improvement of process control. Actuators are very often overlooked when considering control performance, maintenance costs, and ancillary support costs, yet they play a vital role in overall system importance that directly impacts your company's bottom line.

Honeywell's HercuLine™ electric actuators eliminate the characteristic shortcomings of pneumatic actuation as well as many electric actuator competitors. Engineered for very precise positioning, HercuLine actuators perform especially well in extremely demanding environments requiring continuous duty, high reliability, and minimal maintenance.

Honeywell's non-contact position sensing eliminates maintenance and downtime associated with standard slidewire or potentiometer position indication.

Heavy-duty die casting, brakeless non-backdriving gear train, non-burnout synchronous motor, + 85 °C temperature rating, and simple electronics make for a virtually maintenance free product.

Repeatability of 0.2 % or better ensures optimal final control element positioning and ultimately more precise process control and less waste.



**The 10260A HercuLine™ Actuator**

### Features

- Non-contact position sensing (NCS)
- Slidewire emulation allows PAT control without a slidewire
- Extremely precise positioning
- Temperature rating of +850C for high temperature applications
- Simple proven design with 45+ years field experience
- Field reversible rotation without re-calibration
- Dedicated wiring terminals
- All-position mounting
- Linkage kits
- Two year warranty

### Benefits

- Slidewire maintenance and nuisance shutdowns eliminated
- Increases reliability
- Tighter process control, less process variance, and less wasted process costs
- Long term reliability assurance
- Maintenance-free operation.
- Simplified installation into existing applications with space restrictions
- Easy installation and field changes



## **WARRANTY/REMEDY**

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While we provide application assistance personally, through our literature and the Honeywell web site, it is up to the customer to determine the suitability of the product in the application.

For application assistance, current specifications, or name of the nearest Authorized Distributor, check the Honeywell web site or call:

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